UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2000/2001 Academic Session

SEPTEMBER / OCTOBER 2000

EAL232/3 – Highway Engineering

Time : [3 hours]

Instruction to candidates:-

1. This paper consists of **SEVEN (7)** questions. Answer **FIVE (5)** questions only.

2. Answers **MUST BE** written in Bahasa Malaysia.

1. (a) State **THREE (3)** principles of highway construction propounded by John Macadam that is applied until today. Sketch the pavement structure suggested by Madacam.

(5 marks)

(b) A highway pavement is to be built on fine grained soils. State the geotechnical problems that may be encountered. What steps can be taken to solve the problem of constructing such pavements on:

- natural soils
- an embankment

(9 marks)

(c) In the process of route location, state **THREE (3)** justifications to upgrade an existing road.

(6 marks)

2. (a) State **FOUR (4)** adverse effects to a pavement as a consequence of neglecting the provision of surface drainage system.

(8 marks)

(b) Roads are cambered to promote surface drainage. Sketch various forms of road camber and briefly discuss the advantages of each shape.

(3 marks)

(c) What are the requirements of aggregates to be used in bituminous mixes? Discuss the factors that you will consider to evaluate the suitability of aggregates as a road building material.

(9 marks)

3. (a) State the advantages of using emulsified bituminous mix compared to bituminous mixes incorporating cutbacks.

(4 marks)

(b) The results of the penetration tests at various temperatures on bitumen A and B is shown in Table 1.

i. What do you understand by the term Penetration Index and its significance?
ii. What do you understand by the term equi-viscous temperature?
iii. Determine the Penetration Index of both bitumen based on the results of the penetration and softening point tests.
iv. Determine the Penetration Index using the nomograph given in Appendix A. **Detach and include this Appendix in your answer script**.
v. Using the graph paper provided, draw graphs relating the logarithm of penetration against temperature for both bitumen. Comment on the shape of the curve. Determine the gradient of the line and hence the Penetration Index of both bitumen.
vi. Compare the results obtained and comment on the temperature susceptibility of bitumen A and B.

Table 1

Bitumen Property	Bitumen Type	
	A	B
Softening Point (^oC)	70	44
Penetration (dmm) at temperature:		
5 ^oC	32	49
10 ^oC	-	70
15 ^oC	55	100
20 ^oC	-	144
25 ^oC	88	201
30 ^oC	115	299
40 ^oC	184	-
45 ^oC	237	-

(16 marks)

4. (a) What are the differences between asphaltic concrete and porous asphalt? Give your comments on the rate of bitumen hardening that takes place in both mixes.

(4 marks)

(b) In many mix design methods, air voids or mix porosity is specified. Explain the meaning of this term. Sketch and explain the relationship between porosity and bitumen content. Why does many mix design methods specify a range of acceptable mix porosity?

(10 marks)

(c) The Malaysian Public Works Department mix design practice is based on the Marshall method. Sketch the following relationships:

- Density versus bitumen content
- Stability versus bitumen content
- Porosity versus bitumen content
- Flow versus bitumen content

Indicate the method used to determine the optimum bitumen content.

(6 marks)

5. (a) Name **TWO (2)** main input which are required to design pavement thickness using thickness design nomograph as practice by JKR.

(3 marks)

(b) What are the **THREE (3)** main purposes of rolling the asphaltic concrete surfacing

(3 marks)

5. (c) Describe **THREE (3)** alternatives which can be taken if the required thickness cannot be constructed as per designed because of headroom constraint

(6 marks)

(d) Rolling is an essential process in the construction of flexible pavement surfacing. Discuss **THREE** (3) phases of rolling upon the completion of joint and edge rolling.

(8 marks)

6. (a) A road is to be constructed on a subgrade with California Bearing Ratio (CBR) of 6% to take an equivalent standard axle of 10 million after 10 years design period. The thickness of the pavement courses are as follow :-

Sub-base course	-	200mm
Lower road base course	-	200mm
Upper road base course	-	150mm
Binder course	-	100mm
Wearing course	-	50mm

Suggest suitable materials for each courses. Give your reasons for suggesting such materials.

(10 marks)

(b) Standard axle load is used to predict the stress imposed on the pavement. Explain how a truck which carry heavier payload cause less damage on a pavement compared to a truck which carry less payload.

(10 marks)

7. (a) Give **FIVE (5)** types of failure commons on flexible pavement. What is corrective action to each one of them.

(10 marks)

(b) Explain, with a suitable sketch the main difference between flexible and rigid pavements in term of load transfer.

(5 marks)

(c) The edge of concrete slab in rigid pavement must be thicker than the entire slab. Explain why.

(5 marks)

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